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MICROFILMED (M.F.) 50

First Electric Power System in Aerospace

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Washington, D.C., 20546

N66 27080
(ACCESSION NUMBER)

(THRU)

(CODE)

03
(CATEGORY)

4
(PAGES)

JMX-56704
(NASA CR OR TMX OR AD NUMBER)

FACILITY FORM 602

One of the indispensable parts of every manned and unmanned space vehicle is a source of electric power, which may be used for communication, command and control, guidance, radar, image acquisition and transmission, data handling and storage, life support, etc. With few exceptions, space power systems have included electrochemical energy storage devices or batteries. Because of the vital importance of batteries to the space program, NASA is supporting a program of research, development, testing, and evaluation of batteries, including both conventional and novel materials and concepts. By its very nature, this activity is not historically oriented. What follows is, therefore, the product of strictly extracurricular research. The facts and events to be related seem to have but a tenuous bearing on the space age. And yet, these happenings foreshadowed what was to follow more than 85 years later.

On July 19, 1870, France declared war on Prussia. Exactly two months later, Paris was completely encircled by German troops. And on January 28, 1871, the armistice was signed by which Paris surrendered and the war was essentially ended. France had been quickly and decisively beaten on the



ground. It was undoubtedly of small comfort to the French that they had been completely victorious in the air. During 4-1/2 months of siege, Paris had instituted the world's first airlift, during which 66 manned balloons carried more than 160 persons, 400 pigeons, 6 dogs, astronomical and photographic equipment, two cases of dynamite, and over 20,000 pounds of mail, equivalent to 2-3 million cards and letters. The complete history of ballooning during the Franco-German war is a fascinating chapter of the history of technology. It includes such firsts as V-mail, airletters, air mail regulations, large-scale and official use of microphotography (for the V-mail pigeon post into Paris), regular air passenger and cargo service, and Krupp anti-aircraft cannons.

Seventy balloons were mass-produced by private enterprises in two temporarily abandoned railway stations, where pilots also received training of sorts. There were qualification and acceptance specifications, a penalty clause for late delivery, and contract renegotiation then as now. The airlift succeeded despite the fact that there had been no military preparations for it before the war started, nor indeed until mid-September. Only two balloons were lost at sea, but some of the others were driven into German-held territory and even deep inside Germany proper, as might be expected.

Through November 12, 1870, 28 manned balloons had made daylight ascents. Though the Germans had shot at a number of these, they had captured only the "Daguerre" by

this means (and not with one of the 20 or so anti-aircraft cannons at that). However, official Paris was worried about the safety of their aircraft and ordered night flights from then on. The only later daytime start was that of the "Egalité", a privately financed balloon piloted by one of the few remaining balloonists of Paris. His thesis was that the balloons could climb high enough to be out of German reach. He was right, too, but the government did not believe him.

Since a balloon is carried by the wind, balloonists flying at night would find it virtually impossible to use their unaided senses to tell them whether they were rising or falling. That the night flights were equipped with lights is known from contemporary sketches. After a long search for a description of this apparatus, I found it upon spending two vacation days at Harvard's Houghton Library, at the suggestion of Dr. Melvin Kranzberg. In a collection entitled "Journaux de Paris", vol. 4, December 1-31, 1870, there is a brief article in "Le Rappel", No. 544, Thursday, December 8, 1870, page 2, column 3:

The Aeronauts' Lamp

"Before the siege of Paris, no one bothered with the problem of how to light a balloon. Aeronauts left by day and descended at nightfall. Today, since good King William [soon to be Emperor Wilhelm of Germany - EMC] condemns to death all air travelers that come down in the Prussian lines, one must break through the encirclement around Paris at night.

"Hence the aeronaut must have a light. But a flame, subject to the capricious influence of the wind, would be terribly dangerous. The Aeronauts' Lamp must thus be precisely the one that protects miners from their enemy firedamp, the lamp that is operated by an electric spark.

"On a shoulder strap, the aeronaut carries a pouch containing 3 objects: battery, induction spool, and lamp. All of this takes barely more space than a pouch. -- The battery is the potassium bichromate type (zinc, carbon, potassium bichromate with sulfuric acid); its special construction is such that, carried in one position it does not operate, while current is produced when the system is inverted.

"It is thus used up in proportion to the required output only. The battery is enclosed in a hard rubber bottle that is absolutely impermeable. The spark generator is an induction spool, often referred to by the name Rumhkoff [Heinrich Daniel Ruhmkorff, 1803 Hannover - 1877 Paris (EMC)]. The apparatus is reduced to the smallest dimensions and fastened in the pouch near the battery. A switch, thrown one way or the other, starts the discharge or stops it.

"As for the lamp, it is based on a very interesting principle which combines several physical observations. A spark produced in an evacuated tube produces a feeble light; but let us imagine that this tube becomes a tight and long spiral, turned around itself so as to form a short cylinder, then the illumination will be quite bright. If the glass is phosphorescent, i.e., itself capable of giving off luminous

excitation produced by the spark, the lighting effect will be greatly amplified.

"The electric spark can pass only in a tube from which air has been evacuated; thus, if a fracture occurs, the air re-enters and the electric current is interrupted, so that the spark cannot pass to the balloon. [Balloons were filled with flammable town gas, so the device was fail-safe - EMC].

"The aeronaut thus has at his disposal a lamp that is powerful enough to permit him to read, to check his equipment, to study the surrounding atmosphere, and to search for terrain suitable for landing."

Although this article describes the general miniaturized fail-safe system, the details appear to have varied. Specifically, the balloon "La Ville d'Orléans" most likely carried a battery of Daniell cells. This balloon started at 11:40 PM on November 24, 1870, and landed almost 15 hours later and 770 miles away in Norway. It set the long distance record of the air lift and travelled at the remarkable (but not record) average speed of almost 50 mph. The balloon and its equipment were donated to the University of Christiania, now Oslo, for exhibition, the entrance fee being for the benefit of French war victims. In fact, it was a study of the details of this flight that resulted in my finding the article that is translated above. Its battery description fits the Poggendorff-Grenet cell (1856).

The Norwegians, whose sympathies were overwhelmingly on the French side, capitalized on this extraordinary event to express their political feelings. Among many tokens of affection and methods for helping the French, they coined a commemorative medal that was struck and sold at a benefit bazaar in Oslo late in January 1871. The bronze metal was derived from "parts of the balloon", a puzzling statement explained in an article in "Dagbladet" for January 23, 1871:

"There is a large crowd around a great press, where 5 or 6 men in smocks are hard at work. What is it? We read a sign that goldsmith Thostrup is minting bronze medals from the copper and zinc plates in the electrical battery that was on the balloon "Ville d'Orleans" that landed on Lifjeld [that is where the two balloonists jumped out; the balloon landed more than 60 miles farther northeast - EMC]. The aeronauts carried it so that they might quickly transmit news from Paris to the government delegation at Tours, should they land near a telegraph line [this is pure fantasy, of course - EMC]. The small, pretty balloon medals are quickly struck and naturally find many buyers. Those who want the medal gold-plated can have it done on the spot; an electric battery is in use; it can be noticed in the air even before one pushes to the fore to see how galvanoplastic gold finishing is done."

Thus, there are indications that at least two different batteries were flown in 1870, apparently the first time auxiliary electric power was airborne.

The portable electric miners' safety light must have been in use for only a short time and then been completely forgotten. The earliest recorded use of portable electric mine lights is around 1900. Yet there can be no doubt that this "multiple reserve" battery, connected to an early fluorescent light through a spark coil, preceded the battery-powered filament light by about a generation.